High Vertically Resolved Atmospheric State Revealed with IASI Single FOV Retrievals Under All-Weather Conditions

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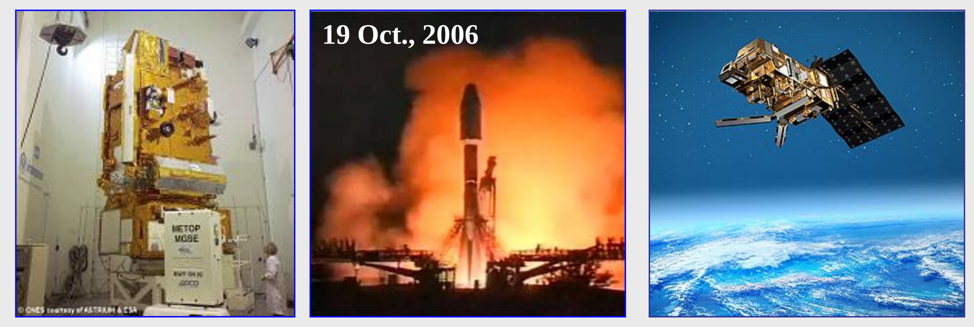
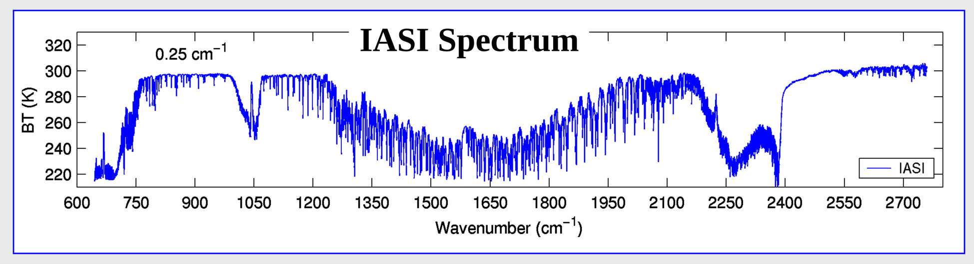
INTRODUCTION

The Infrared Atmospheric Sounding Interferometer (IASI) on the MetOp satellite was launched on October 19, 2006. The Joint Airborne IASI Validation Experiment (JAIVEx) was conducted during April 2007 mainly for validation of the IASI on the MetOp satellite. IASI possesses an ultra-spectral resolution of 0.25 cm^{-1} and a spectral coverage from 645 to 2760 cm^{-1}. Ultra-spectral resolution infrared spectral radiance obtained from near nadir observations provide atmospheric, surface, and cloud property information. An advanced retrieval algorithm with a fast radiative transfer model, including cloud effects, is used for atmospheric profile and cloud parameter retrieval. Preliminary retrievals of atmospheric soundings, surface properties, and cloud optical/microphysical properties with the IASI observations are obtained and presented. These retrievals are further inter-compared with those obtained from airborne FTS system, such as the NPOESS Airborne Sounder Testbed – Interferometer (NAST-I), dedicated dropsondes, radiosondes, and ground based Raman Lidar. The capabilities of satellite ultra-spectral sounder such as the IASI are investigated to benefit future NPOESS operation.

Infrared Atmospheric Sounding Interferometer (IASI) instrument (by CNES/EUMETSAT) on MetOp-A Satellite launched on 19 October 2006





RETRIEVAL METHODOLOGY (Single FOV under all-sky conditions)

PART A: REGRESSION RETRIEVAL (Zhou et al., 2005)

Diagnose 0-2 cloud layers from radiosonde relative humidity profile:

A single cloud layer is inserted into the input radiosonde profile. Approximate lower level cloud using opaque cloud representation.

Use parameterization of balloon and aircraft cloud microphysical data base to specify cloud effective particle diameter and cloud optical depth (Heymsfield et al., 2003):

Different cloud microphysical properties are simulated for same radiosonde using random number generator to specify visible cloud optical depth within a reasonable range. Different habitats can be specified (Hexagonal columns assumed here).

Use LBLRTM/DISORT "lookup table" to specify cloud radiative properties (Yang et al., 2001):

Spectral transmittance and reflectance for ice and liquid clouds interpolated from multi-dimensional look-up table based on DISORT multiple scattering calculations.

Compute EOFs and Regressions from cloudy radiance data base:

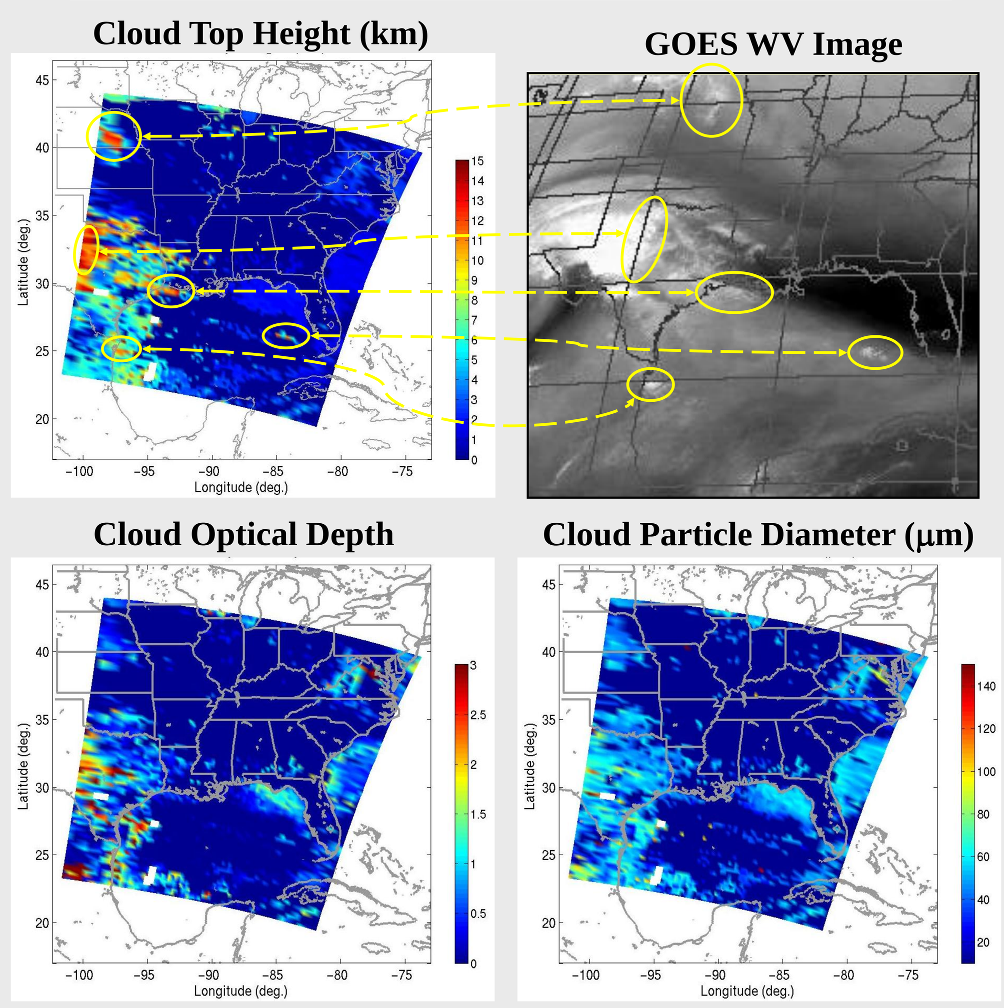
Regress cloud properties, surface & atmospheric profile parameters against radiance EOFs.

PART B: 1-D VAR PHYSICAL RETRIEVAL (Zhou et al., 2007)

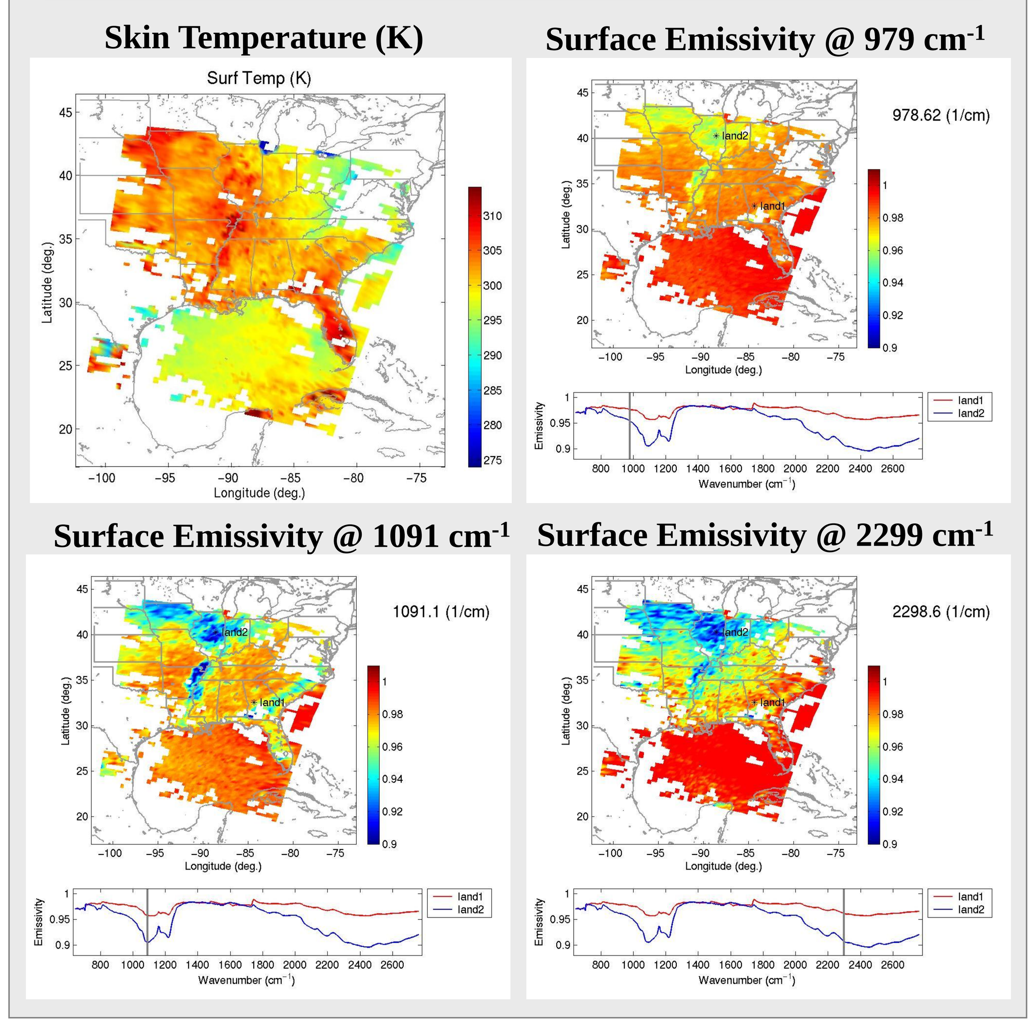
A one dimensional (1-d) variational solution, also known as the regularization algorithm or the minimum information method, is chosen for physical retrieval methodology which uses the regression solution as the initial guess.

Cloud microphysical parameters, namely effective particle diameter and visible optical thickness, are further refined with the radiances observed within the 10.4 μm to 12.5 μm window region.

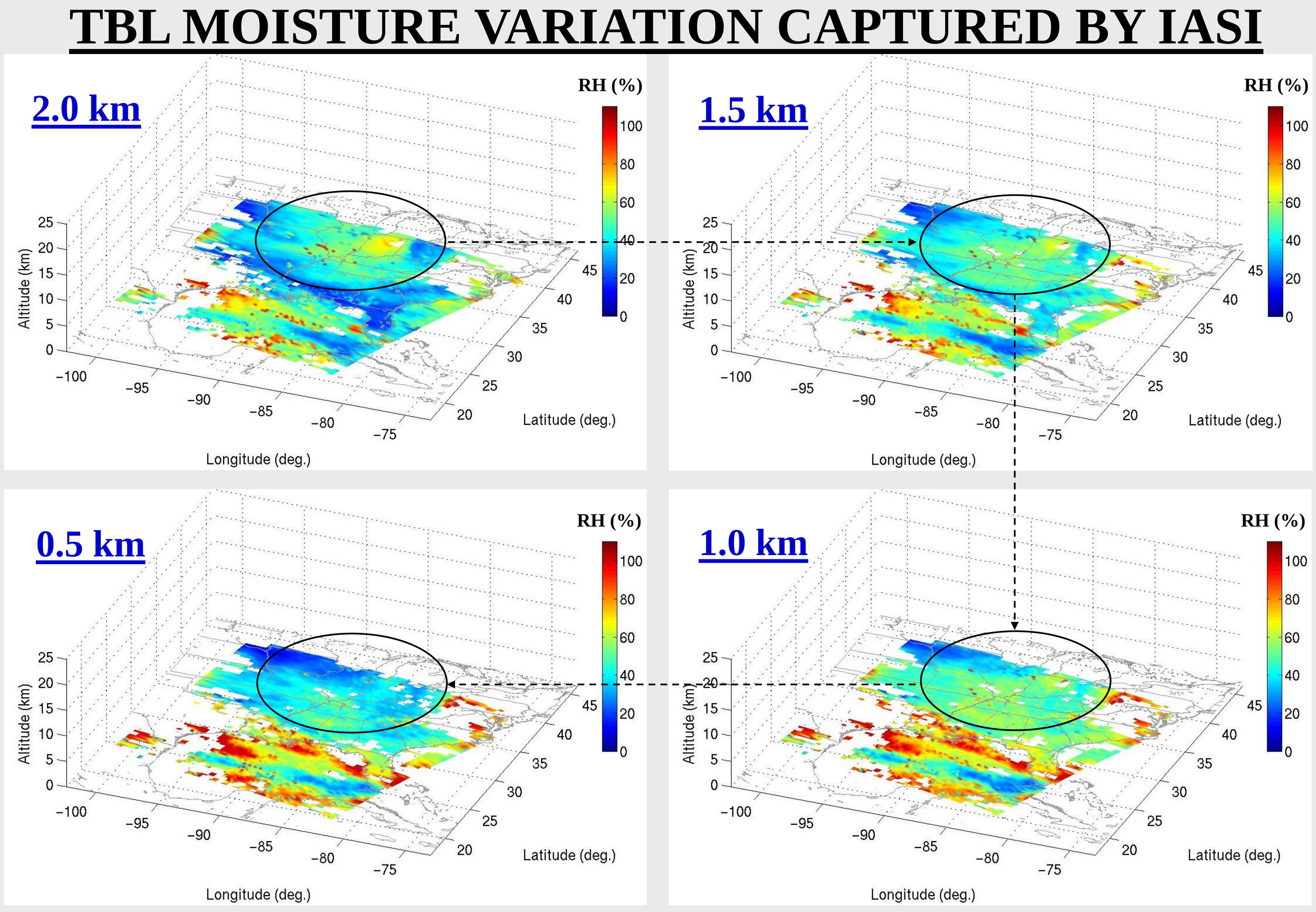
CLOUD PROPERTIES RETRIEVED



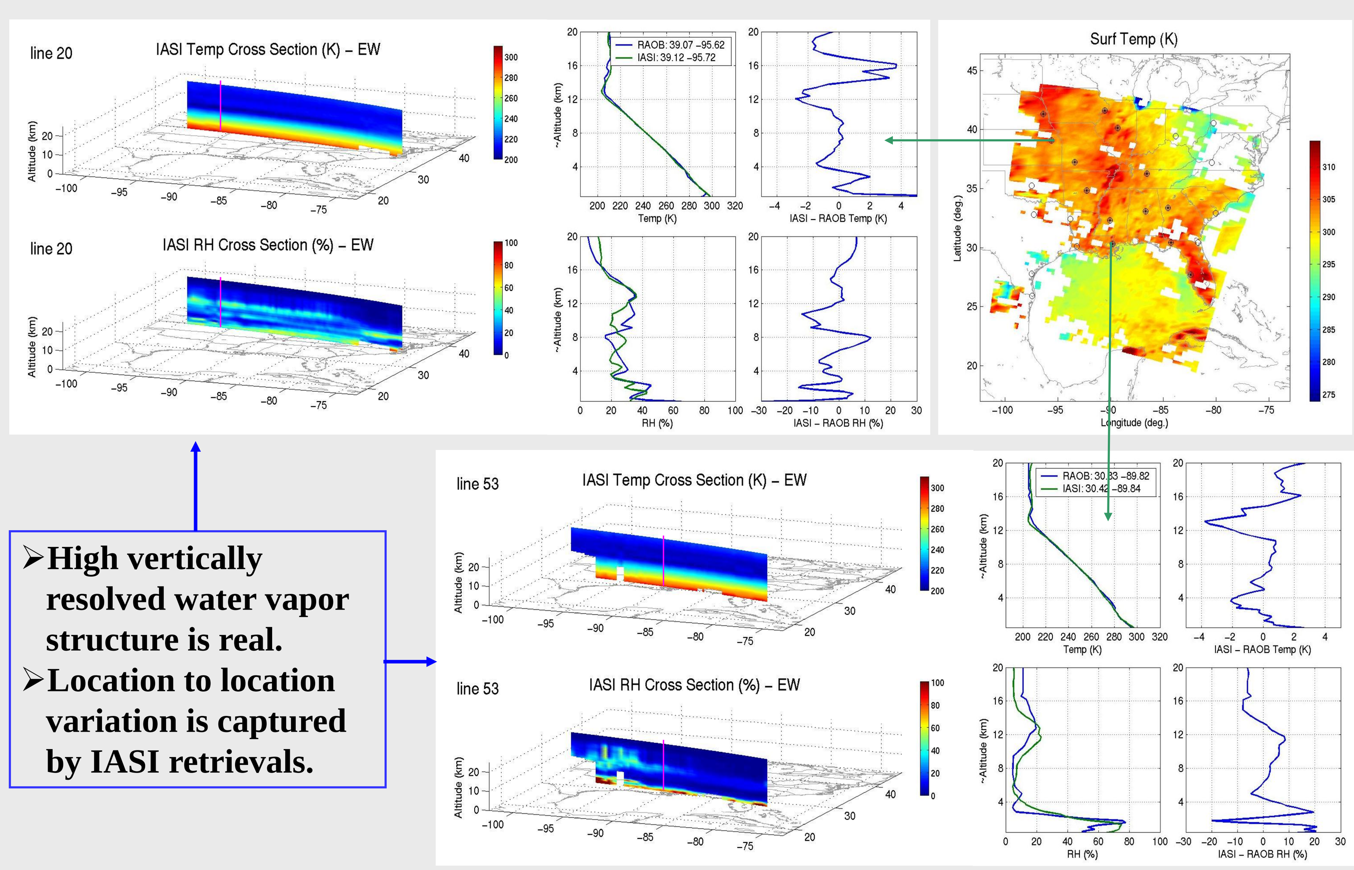
SURFACE PROPERTIES RETRIEVED



TBL MOISTURE VARIATION CAPTURED BY IASI

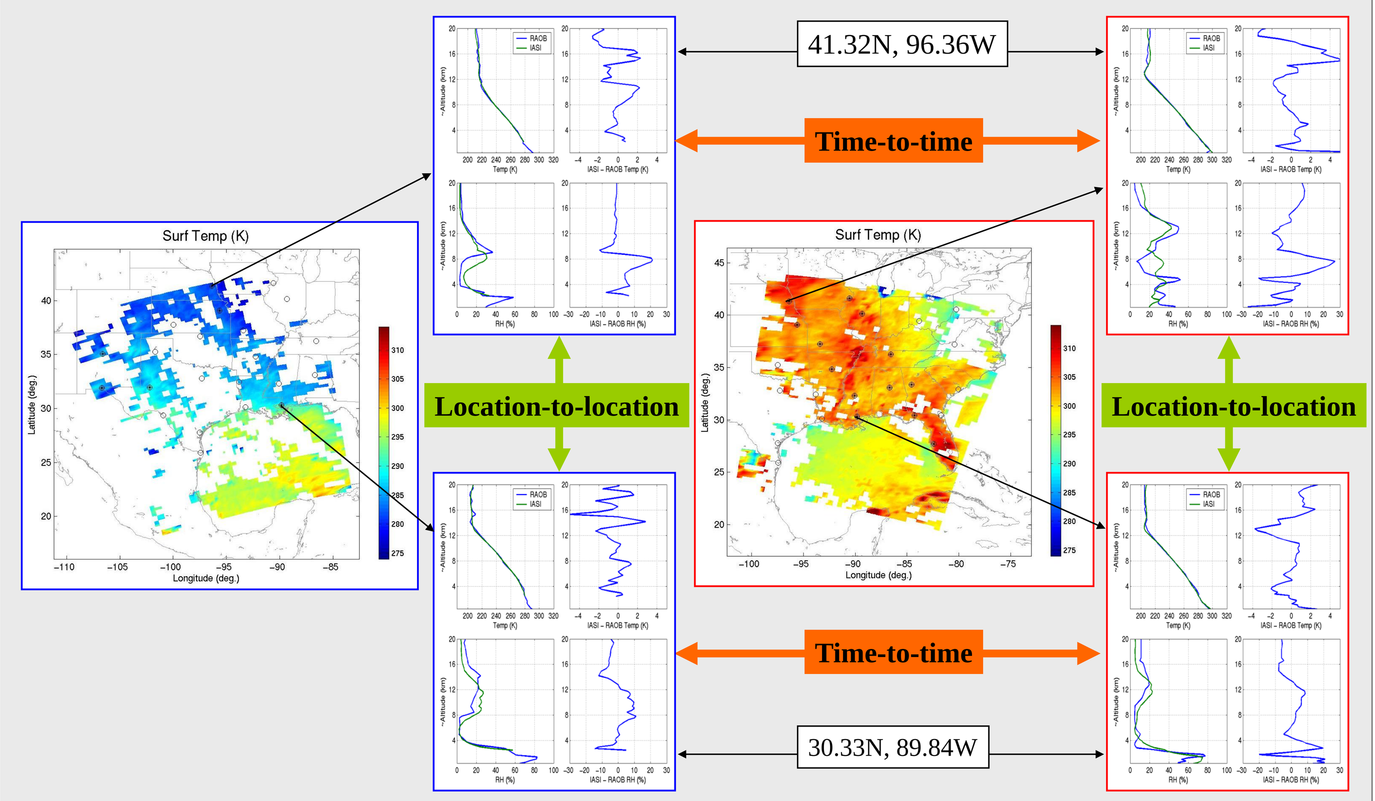


ATMOSPHERIC VARIATION CAPTURED BY IASI

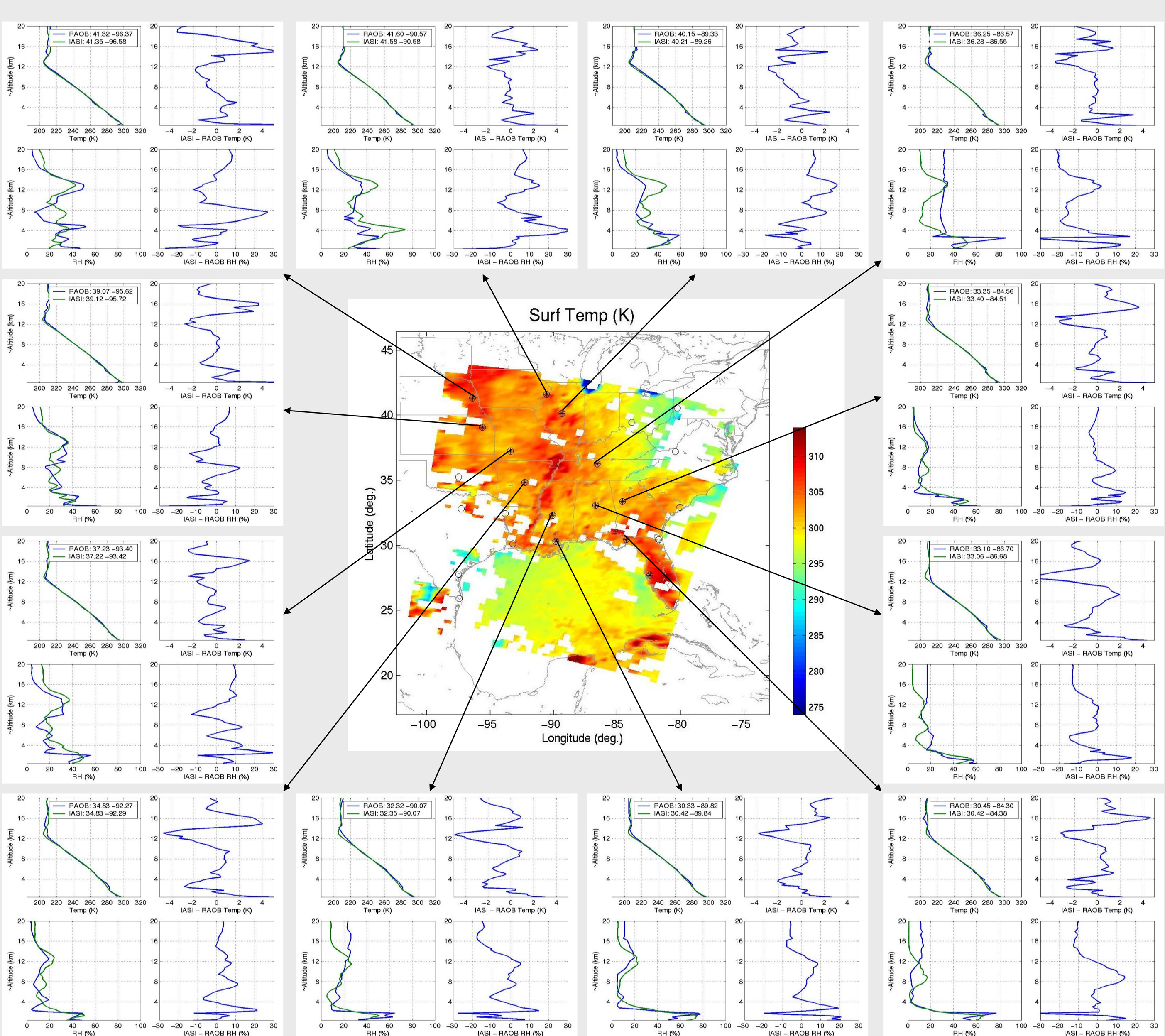


TIME-TO-TIME & LOCATION-TO-LOCATION

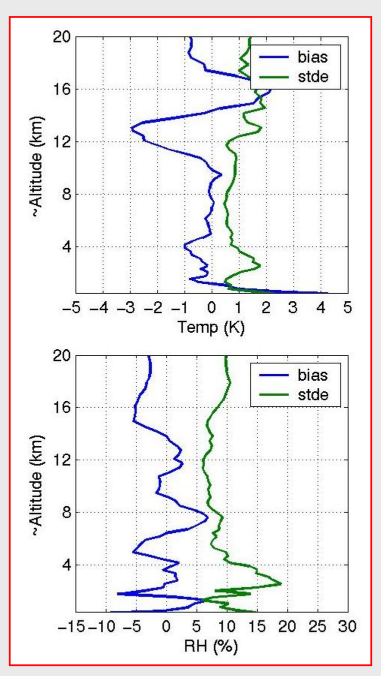
4.19.2007 (0333Z, 2233 Local) **4.29.2007 (1545 Z; 1045 Local)**



IASI (1545 UTC) VS. RAOBS (1200 UTC)



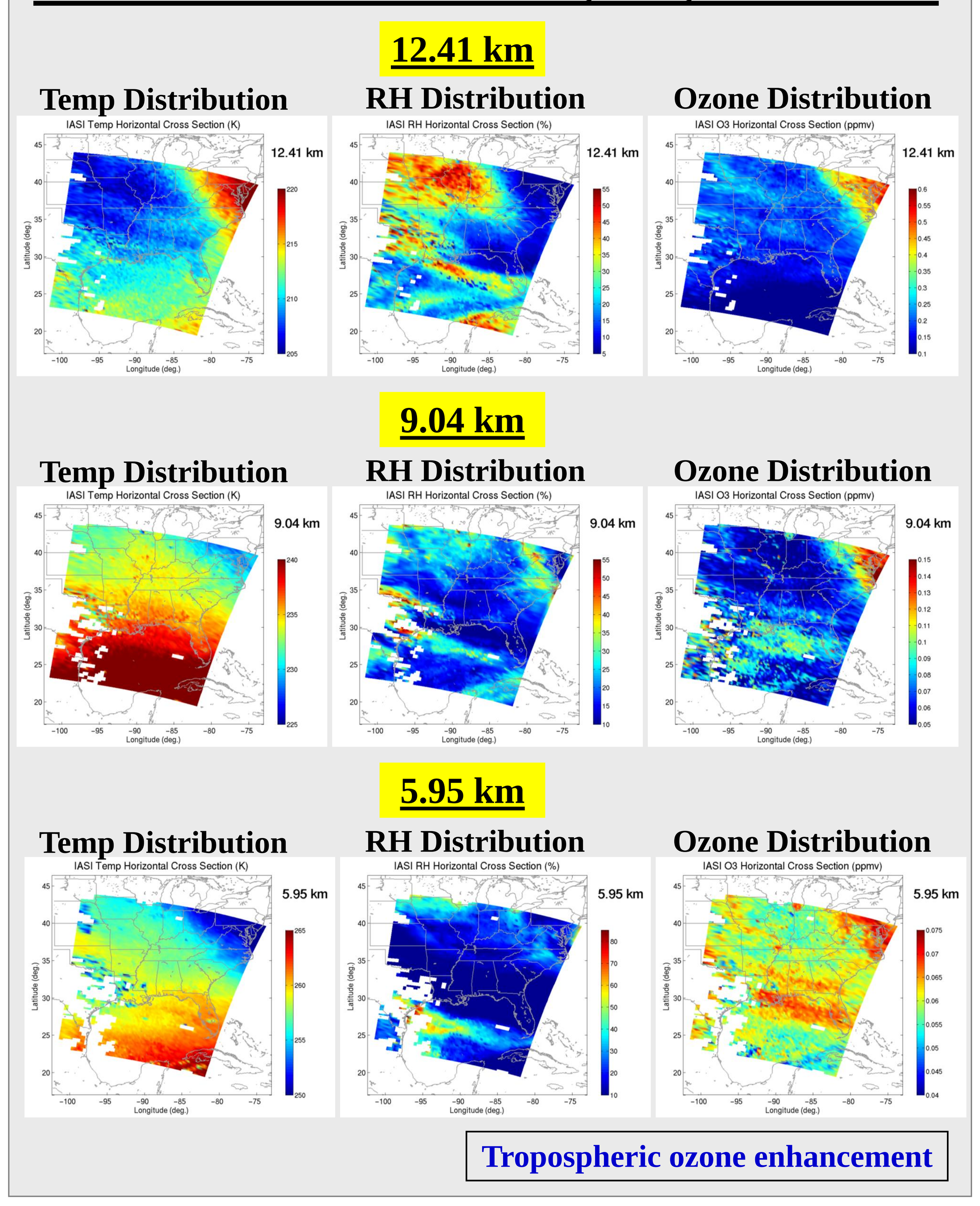
Radiosonde and IASI retrieval comparison and statistical profiles over 13 radiosondes



IASI temperature and moisture profile accuracy is within 1 K per 1 km and 10% per 2 km, respectively (preliminary)

Note:
1200 UTC = 0700 Local
1545 UTC = 1045 Local

TROPOSPHERIC TEMP, RH, and Ozone



SUMMARY AND FUTURE WORK

A State-of-the-art retrieval algorithm dealing with all-weather conditions, developed with NAST-I, has been applied to two satellite instruments retrieving cloud/surface and atmospheric conditions with a "higher" spatial resolution (single field-of-view). First of many case studies of IASI indicate that atmospheric conditions were captured coherently; and initial IASI retrieval comparison with radiosondes is very encouraging as the results are reasonably good. Applying the same algorithm to two satellite instruments allows us to access and/or compare their capabilities (i.e., sensitivity and/or accuracy). The JAIVEx field campaign allows us to reveal the atmospheric temporal variation between two satellites' passes at the same location with aircraft. This work has laid a foundation for some critical studies such as retrieval algorithm refinery, satellite remote instrument validation and inter-comparison, and risk reduction study for future instrument development.

References:

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